Space Weather Technical Forecast

Issued on Monday, 12 December 2022 at 13:16 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of M-class flares throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Low over the past 24 hours, with occasional low-level C-class flares recorded at GOES16. The largest of these flares was a C3.4 at 12/0036 UTC from the vicinity of one of the smaller groups in the northwest, AR3156, however it does possess an east-west orientated magnetic neutral line, and this makes it potentially one to watch for its increased tendency to shear instability. No CME was associated with this flare despite its drawn out X-ray signature.
This is just one of up to ten sunspot regions currently on the visible disc, with the 24-hour period seeing up to three new developing bipolar regions. Along with AR3156 in the northwest, these were the most dynamic on the disc in the period. All regions are now considered to be simple unipolar or bipolar regions, with the largest regions AR3153 (Fho/Beta), AR3157 (Esi, Beta) and AR3163 (Esi/Beta) all relatively stable during the period with little change.
A disappearing filament was noted from the southeastern quadrant around 11/1200-1300UTC in AIA304 and Cerro Tololo H-Alpha imagery, with a northeastern limb prominence erupting at a similar time. Neither of these was obviously attributable to any ejecta seen on coronagraphs, and for now no Earth-directed Coronal Mass Ejection (CMEs) are expected.

Solar Wind / Geomagnetic Activity: Solar winds, as observed at L1 by DSCOVR, were indicative of the waning effects of the fast wind emanating from CH53/-. The phi angle was accordingly towards the Sun (negative) throughout. The solar wind speed was Slightly Elevated throughout (430-500km/s). The solar wind density showed a roughly level tendency near the long-term average (5-10 ppcc), while the IMF was stable and weak, below 7nT throughout. The north-south component showed a range between +/-6nT, but with no protracted aligned or anti-aligned periods noted.
The net result of the above solar wind measures was for Quiet to Unsettled geomagnetic activity (Kp 0-3).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) as measured at GOES16 remained at Background levels.
High energy electron flux (greater than 2 MeV), as observed by GOES16, has been at Background to occasionally Moderate levels. The associated 24-hour fluence remained well below Active (1e8 integrated pfu). Observed fluence at 12/0000UTC was 2.05e6 integrated pfu, with a slowly rising trend at GEO.

Four-Day Space Weather Forecast Summary

Solar Activity: There is a Chance of isolated M-class flares each day, currently most likely from AR3163, AR3153 or AR3157, which are the largest regions on the visible disc, or AR3156 which is the most magnetically complex. Further arriving regions over the coming days may see a further slight increase in activity.

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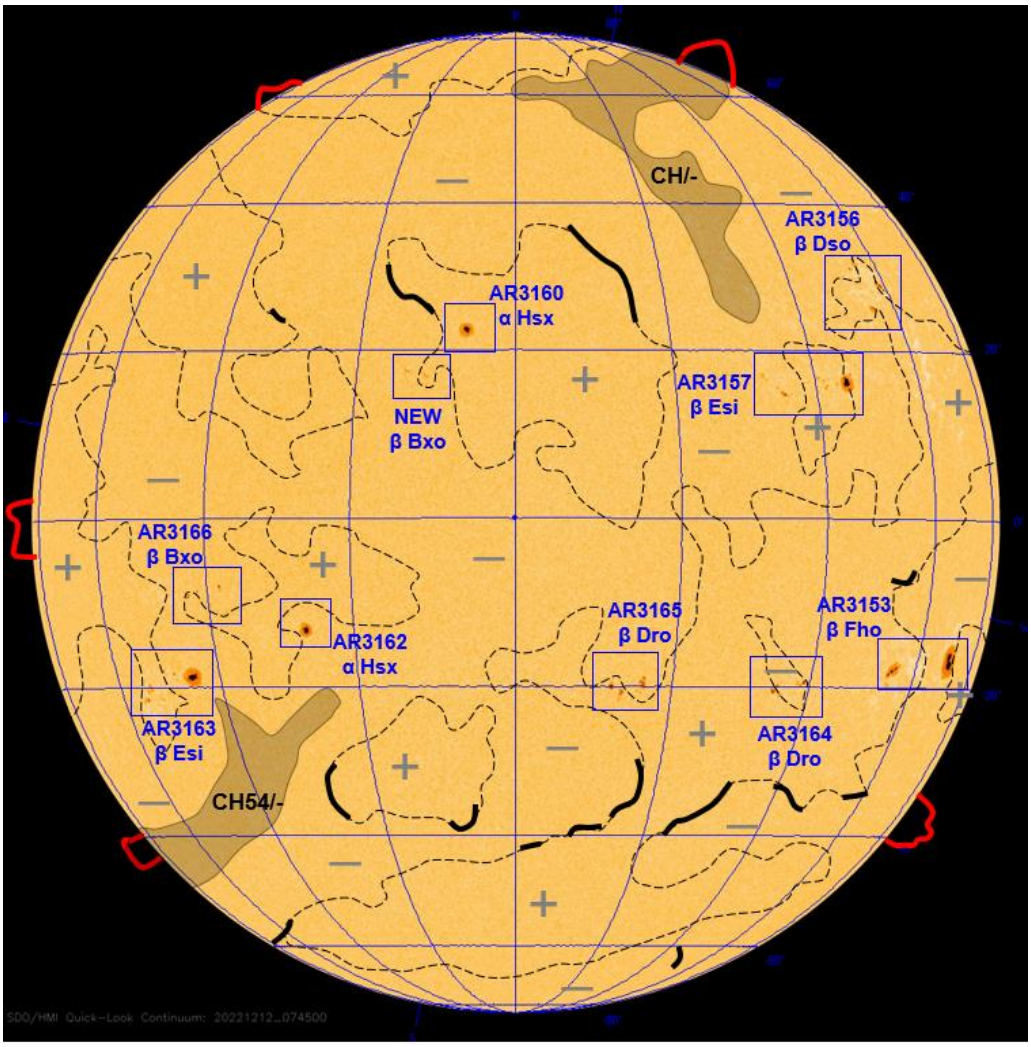
Solar Wind / Geomagnetic Activity: No Earth-directed CMEs currently feature in the forecast. There are up to two fast wind streams due in the four days, firstly the now declining CH53/- on day 1 (12th), but also potentially a minor unnumbered coronal hole that may graze Earth on day 2 (13th). Muted effects are predicted by persistence, if any. Geomagnetic activity is likely to be Quiet to Unsettled on days 1-3 (12th-14th), with chance of isolated Active intervals on day 2 (13th). Predominantly Quiet geomagnetic activity is expected by day 4 (15th).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) is expected to remain at Background levels throughout, with a daily Slight Chance of seeing S1+ levels if any significant flares occur.
High energy electron flux (greater than 2 MeV) is expected to remain at predominantly Background to Moderate levels, but with an increasing trend, which brings a chance of occasional High levels (1000pfu) being reached at times. The corresponding high energy electron fluence is expected to remain below the Active (1e8 integrated flux) threshold, despite the suggested eventual upward trend.

Figure 1. Solar Analysis Valid 12/0800 UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

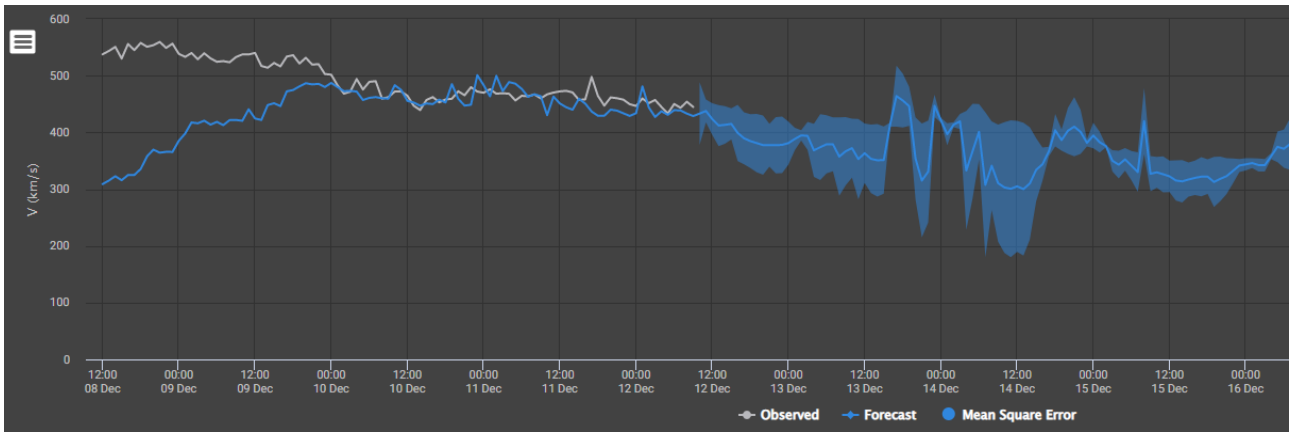
No Earth-directed CMEs feature in the current forecast.
There are up to two fast wind regimes due in the four-day period. The first is a known entity in the guise of the decaying remnant of CH53/-, which has likely delivered its most significant geomagnetic activity and should continue to fade to background.
The second fast wind may arise from a tenuous northern solar hemisphere feature that was present on last rotation, but delivered almost no discernible effect at Earth, perhaps a short-lived very minor 400km/s fast wind that had no discernible geomagnetic effect. MOSWOC Enlil has dealt with this feature in a very erratic manner, with some suggestions of a fast wind of up to 500km/s, but with an onset time varying by 24 hours between 12th and 13th December. There is not yet any sign of any fast wind at STEREO A, which would make the former hypothesis very unlikely, and a slower, later fast wind is therefore favoured, if present at all.
All considered, geomagnetic activity is likely to be Quiet to Unsettled on days 1-3 (12th-14th), with a chance of isolated Active intervals on day 2 (13th) if Earth connects to the fast wind from the un-numbered coronal hole to the north. Predominantly Quiet geomagnetic activity is expected by day 4 (15th).

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	1	5	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Nil.

Figure 2: MOSWOC Solar Wind Persistence Model (SWPM)



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Radio Blackouts - X-Ray Flares:

There are now up to ten sunspot regions on the Earth facing disc, although the majority are long-term stable residents and either simple dipoles, or else unipoles. Even the recent arrival of AR3163 over the southeastern limb has now stabilised somewhat after an entry onto the disc characterised by mid-ranking C-class flares and (non-Earth directed) CMEs.
The daily chances of M-class flares have been revised downwards somewhat relative to the raw probabilities of the contributing sunspot groups, with AR3153 and AR3157 in particular proving far less active than their Zurich classes of Fho and Esi would suggest.
The balance of numbers on the Earth-facing side should initially increase, with the Carrington locations of up to three returning sunspot groups due into the new working week UTC in the form of Ex-3148, 49 and 51. From midweek, AR3153, and perhaps also AR3156, will transit to the far side. This is the rationale for the initial slight rise in daily chances of M-class, followed by a moderation towards the end of the four day period.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	30	40	30	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) is most likely to remain at Background levels throughout. There remains a daily Slight Chance of seeing S1 or greater levels at GEO if any significant flares were to occur. The 5% risk is mainly due to the nominal presence of the three larger sunspots on the Earth facing disc.

Radiation Storms	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability (Exceedance)			(%)	(%)	(%)	(%)
Active	≥ S1	No	5	5	5	5
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

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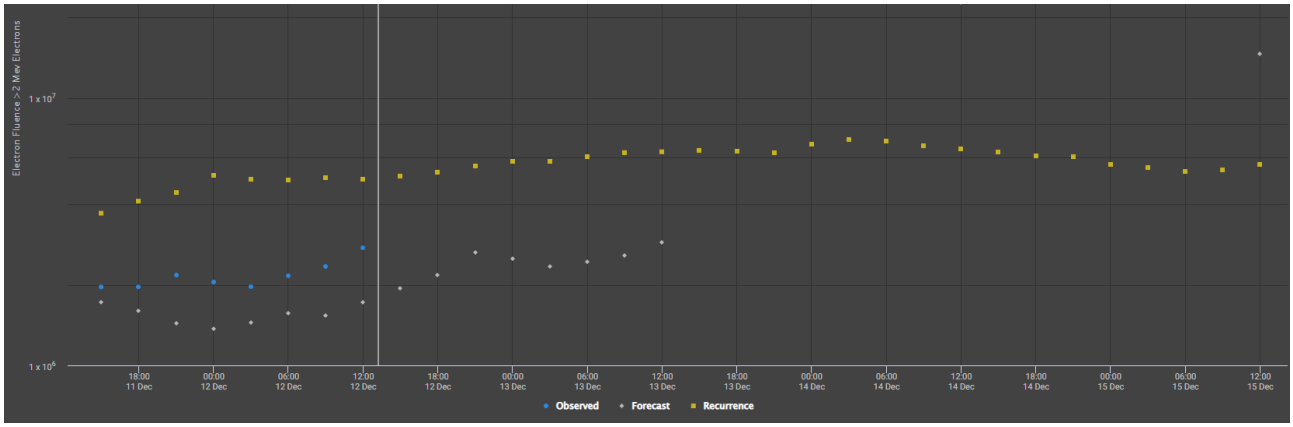
High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) does not appear to have reacted appreciably to the recent fast wind from CH53/-, and its opportunity to do so has now likely passed, with the currently observed steady state in Normal Background to Moderate flux probably the peak from the event.
Any fast wind from CH##/- is likely to be in the slightly elevated range, and this is unlikely to be sufficient to generate Active 24-hour integrated electron fluence, with this rated at a peak Slight Chance for the four days as a whole.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	10	20	20
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Observed electron fluence and REFM forecast data.



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